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THE METROPOLITAN AREA CONCEPT: AN EVALUATION OF THE 1950 SMA'S*

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A selected group of 1950 SMA's are examined to determine the extent to which they comprise self-sufficient trading areas with respect to local service activities. By comparing the self-sufficiency of each SMA to the self-sufficiency of its urbanized area and of an areal unit made up of the SMA plus contiguous counties, the quality of each SMA is evaluated. Each SMA is classified as being either overbounded, underbounded or truebounded. The type of boundary discrepancy exhibited by an SMA is strongly related to its degree of proximity to other SMA's and is unrelated to its population size.

PRESENT day urban research has come to rely increasingly upon conceptualizations of the metropolitan area and upon units of analysis intended to approximate such areas. The development and use of the Metropolitan District by the Bureau of the Census for the censuses of 1910 through 1940 represents one of the earlier attempts to provide statistical units for investigators of urban phenomena which would approximate the more extended urban communities which began to flourish in this century. More recently, in connection with the censuses of 1950 and 1960, the Bureau of the Census and other federal agencies have established the Standard Metropolitan Area (SMA) and the Standard Metropolitan Statistical Area (SMSA) in an attempt to delineate an areal unit which is generally even more extensive than the Metropolitan District in order to provide a suitable approximation to our theoretical understanding of a metropolitan area.

With the increasing utilization of and dependence upon such units of analysis by both professional and nonprofessional analysts of urban phenomena it is perhaps time that some of those most closely involved with the understanding of urban form and development take a closer look at the statistical creatures which have been created for their benefit. With the next decennial census approaching it appears likely that still further refinements and modifications of these types of units will be attempted. Now would appear to be the time for those engaged in urban research to undertake some efforts to evaluate and criticize these statistical artifacts in the light of their individual theoretical perspectives and interests. Such evaluations are essential if we are to maintain any awareness of the statistical world with which we deal and if we hope to have some effect upon its future refinements.

This paper reports upon an attempt to examine the validity of one form of metropolitan area from a particular theoretical perspective. It is hoped that a number of such evaluations by persons representing divergent interests and perspectives will help to shed greater light upon the meaning and importance of the units of analysis with which we are all most commonly engaged. After classifying each of the 1950 SMA's according to their ability to adequately approximate localized trading areas, the effect of the size of the SMA and its proximity to other SMA's is examined briefly in order to verify the hypothesized relationship between such factors and the quality of the SMA.

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* The research upon which this paper is based is derived from the author's Ph.D. dissertation for the Department of Sociology, University of Michigan: *The Local Ecological Community: An Investigation of Relative Independence in an Urban Society.* (Ann Arbor: University Microfilms, Inc., 1963)

Aside from the relatively simple question of evaluating the Standard Metropolitan Areas, the methodological techniques elaborated here may have a number of implications for the general problem of community and regional area delimitation. The limitations of space do not permit an elaboration of all these implications at this time, however.

1. THE CRITERIA OF EVALUATION

In their work on the delimitation of the world's metropolitan areas, the members of the International Urban Research Institute recognized three logical possibilities of discrepancy in the delimitation of an urban aggregate: the underbounded city in which the city is smaller than the urban aggregate it is intended to represent, the overbounded city in which the city is larger than the urban aggregate it is intended to represent, and the truebounded city in which the city is virtually identical with the urban aggregate it is intended to represent.[1] Following these three "Goldilocks" possibilities of discrepancy, we shall attempt to evaluate each of the 1950 SMA's[2] as being either underbounded, truebounded or overbounded with respect to the metropolitan area it is meant to represent. Thus when a particular SMA is said to be underbounded in this analysis we mean to imply that, according to our theoretically derived standards, the SMA is less extensive, both in areas and in population size than the metropolitan community in that locality. In simpler terms, an underbounded SMA may be said to be "too small" while an overbounded SMA may be said to be "too big" and a truebounded SMA may be said to be "just right."

The critical consideration in such an evaluation is, of course, the matter of the standards by which the adequacy of a particular SMA is to be judged. Although the operational criteria by which the SMA's were delimited in 1950 are relatively straightforward and are quoted verbatim in almost every text which gives serious consideration to the metropolitan area in the United States, conceptual interpretations of the metropolitan area that would lend themselves to empirical evaluation are much more difficult to find in the literature. A few of these conceptual interpretations are presented here to afford some greater insight into the meaning of the SMA than is generally afforded by a simple quotation of its method of operational delimitation.

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[1] International Urban Research, *The World's Metropolitan Areas.* (Berkeley and Los Angeles: University of California Press, 1959), pp. 6–9.

[2] The Standard Metropolitan Areas subjected to analysis in this paper are actually only 103 in number. This group of SMA's differs from the 168 SMA's used in the 1950 census in two respects. All 59 of the SMA's which lie in the 12 states plus the District of Columbia classified as southern by the Bureau of the Census have been omitted from the analysis Their omission from the initial analysis appeared to be necessary in order to minimize the distortion inherent in the use of location quotients which arise through rural-urban differences in consumption and production patterns and through the rather marked discrepancies in consumption and production which exist in the South relative to the rest of the United States. For a more complete discussion and documentation of the considerations leading to the decision to omit southern SMA's see Allan G. Feldt, *op. cit.*; pp. 40–1 and 68–74. The second important way in which the SMA's analyzed here differ from the original 168 established by the Bureau of the Census is in the treatment of the 18 New England SMA's. We have followed Bogue's convention of utilizing only 12 New England SMA's delimited on county lines and corresponding to the State Economic Areas rather than adopting the 18 SMA's delimited on township lines by the Bureau of the Census. For a discussion of the rationale behind this treatment of the New England SMA's see Donald J. Bogue, *Population Growth in Standard Metropolitan Areas, 1900–1950; With an Explanatory Analysis of Urbanized Areas* (Washington, D. C.: Housing and Home Finance Agency, 1953), pp. 10–11.

> It has long been recognized that, for many types of social and economic analysis, it is necessary to consider as a unit the entire population in and around the city whose activities form an integrated social and economic system.[3]
>
> The underlying concept is that of a large city with its satellite cities and outlying suburbs. These suburbs go beyond the urban territory to include a farther zone where many of the residents have daily social and economic contact with the central city, the proximity of which affects their way of life and uses of land.[4]
>
> Such [metropolitan] areas are meant to include the territory surrounding a city if it represents a continuous extension of the city or if the people living there are predominantly connected with the city in an intimate day-to-day economic and occupational sense.[5]

These interpretations make it clear that the SMA is intended to include with the central city those populations surrounding it that are characterized by a high degree of interaction and interdependence with the central city. Although such integration may take on a wide variety of forms of social and economic intercourse, the fundamental basis for such territorially integrated systems is usually to be found in the exchanges of goods and services among functionally specialized subpopulations which evolve out of their aggregate solutions to the task of producing and consuming the daily sustenance requirements of such a population.[6] Concentrating our attention upon such ecological exchanges, we may then define the SMA conceptually as comprising *that area the resident population of which is interrelated and integrated with reference to the provision of its local service requirements.*[7]

The means by which we will attempt to evaluate the adequacy of the boundaries of a particular SMA will then be based upon an attempt to determine the extent to which the SMA boundaries provide a reasonable approximation to the boundaries of the trading areas of the local service industries. The use of trading areas to delimit the extent of spatial aggregates of populations has many precedents in the literature of community studies and is still widely used today.[8] The approach used here differs from most other attempts in a number of particulars, however.

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[3] U. S. Bureau of the Census, *U. S. Census of Population: 1950*, "United States Summary," (Washington United States Government Printing Office, 1953), II, Part I, p. 5.

[4] Henry Shryock. "The Natural History of Standard Metropolitan Areas," *American Journal of Sociology*, 52 (1957), 169.

[5] International Urban Research, *op. cit.*, p. 4.

[6] The primacy of the ecological network of interdependency and exchange in any social system does not appear to be universally accepted by most sociologists. Such a viewpoint is basic to the subfield of sociology known as human ecology, however. See for example the writings of Amos H. Hawley, *Human Ecology* (New York: The Ronald Press, 1950), especially chapter 4.

[7] This interpretation is a simple paraphrasing of one of the definitions of the community offered by Hawley, *Ibid.*, pp. 257–8.

[8] Other uses of trading areas to delimit "community" systems appear throughout the literature of human ecology, urban geography and related fields. A few of the more widely known studies of this phenomenon are: C. J. Galpin, *The Social Anatomy of an Agricultural Village*, Agricultural Experiment Station of the University of Wisconsin, Research Bulletin 34 (Madison, Wis., May, 1915); R. D. McKenzie, "Newspaper Circulation and Metropolitan Regions," in R. D. McKenzie, *The Metropolitan Community* (New York: McGraw-Hill, 1933), Chapt.

Rather than attempting a close examination of a limited range of service activities in each SMA and delimiting a fairly precise boundary for each in turn, we shall begin with several rather arbitrary boundaries and attempt to determine how well these arbitrary boundaries approximate the trading areas for all of the local service activities at once. Furthermore, this study attempts to analyze a large number of SMA's simultaneously. Therefore, the methods of determining trading areas of individual services are necessarily more generalized and more crude than those more commonly employed such as the analysis of addresses of charge account customers, the extent of delivery routes, or the shopping patterns of individual families. Certainly there are dangers inherent in a broad macroscopic analysis of this type and the findings presented here may not in every case stand up against those obtained by a more detailed analysis of specific localities.[9] Nevertheless, we believe that our results have a high degree of general validity and that a method of analysis such as that employed here is entirely appropriate for the ends being sought, i.e., a general evaluation of the validity of the use of the SMA delimitation throughout most of the United States.

For each of the SMA's to be examined three areal units will be analyzed: one smaller in extent than the SMA, one equivalent to the SMA, and one considerably greater in extent than the SMA. The degree to which each of these three areas provides a good approximation to the trading areas for local service activities will be determined and the SMA will be classed as underbounded, truebounded, or overbounded according to the type of configuration which seems to provide the best approximation to the local service trading area. Thus, when an areal configuration smaller than the SMA is found to provide a better approximation to the local service trading area than the SMA for a particular locality, the SMA will be classed as overbounded. In such an instance it is quite likely that economic and social integration with the central city does not extend as far as the SMA boundaries but rather extends only as far as the approximate boundaries of the smaller area analyzed. Conversely, when an areal configuration larger than the SMA is found to provide a better approximation to the local service trading area than the SMA, the SMA will be classed as underbounded. In this case, it is very likely that economic and social integration with the central city of the SMA extends beyond the SMA boundaries to embrace population aggregates living outside of the SMA. Finally, the SMA will be classed as truebounded whenever the SMA itself appears to offer the best alternative among the three areal configurations for a good approximation to the local service trading area.[10]

8; W. J. Reilly, *Methods for the Study of Retail Relationships*, University of Texas Bulletin No. 2944 (Nov., 1929); D. Sanderson and R. A. Polson, *Rural Community Organization* (New York: Wiley & Sons, 1939); W. Firey, C. P. Loomis, and A. J. Beegle, "The Fusion of Urban and Rural," in Labatut and Lane (eds.) *Highways in our National Life* (Princeton: Princeton University Press, 1950); C. D. Harris, *Salt Lake City: A Regional Capital* (Chicago: The University of Chicago Press, 1940); and H. L. Greenwood, "Hinterland Boundaries of New York and Boston in Southern New England," *Economic Geography*, 31 (Oct. 1955), 283–300.

[9] Madison, Wisconsin offers a good example of a community where more precise local data would probably be preferable to those used here. See footnote 21.

[10] The degree to which economic and social boundaries coincide in the delimitation of community systems is a matter which has been subjected to considerable speculation but little empirical research. The tacit assumption in this paper is that economic and social systems are approximately coterminous. Closer examination of this assump-

The three areal configurations which are examined here were chosen primarily according to the availability of the appropriate data for the analysis. They are not intended to offer definitive delimitations of real or meaningful trading areas for metropolitan areas but are employed simply in order to offer alternatives to the SMA itself which are both lesser and greater in areal extent than the SMA. The unit smaller than the SMA which is examined is usually the urbanized area of the central city as defined and delimited by the Bureau of the Census.[11] When an urbanized area has not been delimited, the central city itself is employed as the unit smaller than the SMA. For multiple central city SMA's the unit smaller than the SMA is made up of the combination of urbanized areas of central cities or the multiple cities according to whichever is available.

The unit larger than the SMA has been taken as the SMA itself plus all contiguous nonmetropolitan counties surrounding the SMA.[12] This unit is considerably greater than the SMA in most instances and provides a reasonably good test of the possible necessity for considering a more extended areal unit than the SMA itself. We do not mean to infer from this analysis, however, that SMA's which are classed as underbounded should be enlarged to include all the counties surrounding it which are considered here. The only inference intended is that the SMA should be extended to include *some* of those populations living in the surrounding counties.

2. THE METHOD OF ESTIMATING TRADING AREAS

Although all manner of economic and social transactions take place both within and between modern urban communities, it seems obvious that a substantial proportion of the exchanges taking place *within* a metropolitan area center around the production, consumption, and exchange of those goods and services which are produced by the industries generally classed as local service industries. That these economic activities are locally oriented is true by definition and most discussions of these activities emphasize the limited range of their exchange relationships.

> Similarly, service activities—economic complement of the base—are customarily defined as those transactions involving goods, services, and capital which are purely local in that, in the process of exchange, *they do not cross the line which separates the community from the outer economy of state, region, nation, and international markets.*[13]

> The service industries, however, diverse though they may be in other respects, all share the fundamental characteristic that they can on the whole only be carried out in the city where the consuming population can reach without undue difficulty. A community at any given level of average income expects to consume services up to a cer-

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tion would appear to be one of the paramount issues confronting present day social scientists. It is felt that some of the techniques developed in this paper may provide the means for further investigations along these lines.

[11] U. S. Bureau of the Census, *op. cit.*, pp. 21–2.

[12] The actual delimitation of these contigouus counties was done by the staff of the Program for Research in Population and Human Ecology at the University of Michigan under the direction of Dr. David Goldberg. For a brief description of the selection criteria employed see Allan G. Feldt, *op. cit.*, pp. 51–2. A list of the contiguous counties utilized in this analysis will be made available on request.

An important precedent for the consideration of an extended SMA made up of the SMA plus contiguous surrounding areas may be found in Amos H. Hawley, *The Changing Shape of Metropolitan America* (Glencoe: The Free Press, 1956), pp. 5–73.

[13] Richard B. Andrews, "Mechanics of the Urban Economic Base: The Problem of Base Area Delimitation," *Land Economics*, 30 (Nov., 1954), 309, emphasis mine.

> tain standard and, if there is no city within reasonably easy reach that can fully provide such a standard, the inhabitants of the region must either do without such services altogether or send to or make periodic visits to distant cities for the provision of such services as wholesale trade, insurance, specialist medical services, higher education, etc. A city cannot be said to be of optimum size unless it can provide its own inhabitants and the inhabitants of the surrounding region with at any rate all but the most specialized of such services.[14]

Thirteen categories of industry taken from the 41 item condensed industry classification of the Bureau of the Census were selected to represent local service industries. The industrial categories chosen were examined in ten discrete groups of industrial employment.[15] The composition of these ten groups of local service industries is given in the following list:

Food and dairy product stores and milk retailing
Eating and drinking places *plus* Other retail trade
Utilities and sanitary services
Repair services
Construction
Medical and other health services
Educational services (*both private and governmental*)
Private households *plus* Other personal services
Other professional and related services
Trucking service and warehousing

Location quotients for each of these ten groups of industries for both the SMA's and for the units larger and smaller than the SMA's were computed using industrial employment data from the 1950 Census of Population. The location quotients were computed according to the following formula where I represents the location quotient, e_i represents the local employment in a particular industry category, p represents the total population of the local area, E_i represents the aggregate employment in a particular industry for the entire non-southern United States, and P represents the total aggregate population of the non-southern United States.[16]

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[14] Colin Clark, "The Economic Functions of a City in Relation to its Size," *Econometrica*, 13 (April, 1945), 97–8.

[15] Although the industries selected as service industries correspond fairly closely to lists of local service industries established by other investigators, they were selected independently of other selections and classifications. The method of selection employed was based upon the value of the coefficient of dissimilarity obtained for each industry by comparing its employment distribution to the distribution of population. Ubiquitous industries displaying low values of the coefficient of dissimilarity were those chosen as local service industries for this analysis.

The effect of including or excluding the 59 southern SMA's in the computation of the coefficients of dissimilarity for the various industries was given careful consideration at this point. Indeed, it was at this stage of the investigation that some of the problems inherent in including the southern SMA's in the entire analysis first became apparent. Thus, for example, private household and other personal services do not exhibit low values of the coefficient of dissimilarity when the analysis is conducted upon a group of SMA's including southern SMA's, due to the higher levels of consumption of these types of services which are characteristic of many southern SMA's. Similarly, Medical and other health services appear to be consumed at a slightly lower level in the South than in the rest of the nation and again the local service character of the bulk of these activities tends to be obscured when computations are completed including southern SMA's in the analysis. In every instance the activities selected as local service activities appeared to be more appropriate to our purposes when the southern SMA's were excluded from the analysis.

Additional computations of the coefficients of dissimilarity for industrial categories were undertaken for central cities, urbanized areas, and a random sample of counties as well as for the SMA's. These additional computations did not indicate any major differences in the kinds of economic activities which would be chosen as local service activities on the basis of the coefficients obtained for SMA's alone. For a more complete description of the methods of selection employed see Allan G. Feldt, *op. cit.*, pp. 33–57. A complete listing of all industries included in the 41 item condensed industry classification is given in U. S. Bureau of the Census, *op. cit.*, pp. 58–9.

[16] Numerous discussions and definitions of the Location Quotient appear throughout the literature. A number

$$I = \frac{e_i/p}{E_i/P} \qquad (1)$$

Once these location quotients were obtained for each of the SMA's and for the other units smaller and larger than the SMA, some indication of the extent to which the SMA approximated a trading area for any particular industry could be inferred from the values of the location quotient for that industry. Values of the location quotient which are very close to 1.00 for an SMA would seem to indicate the likelihood that the SMA was "self-sufficient" with respect to the production and consumption of the goods and services connected with that industry. If the SMA value is closer to 1.00 than the values obtained for territorial units either larger or smaller than the SMA, the obvious conclusion would be that the SMA is a unit which is well bounded with respect to the populations integrated and interdependent in the production and consumption of goods derived from the industry in question.[17]

Table 1 presents the values of the location quotient obtained for each of the ten groups of local service industries for three of the 1950 SMA's in order to illustrate the manner in which the values of the location quotient vary when computed for a succession of areas greater than, equal to, and smaller than the SMA itself.

For five of the ten industry groups considered, the SMA of Grand Rapids appears to provide the closest approximation to their trading areas as measured by the extent to which the value of the location quotient approaches 1.00. Similarly the SMA of Salt Lake City appears to provide a close approximation to the trading area for only two local service industries and the SMA of Youngstown for none of the industries.

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of these have been taken into consideration in the formulation of the location quotient employed here. Greatest reliance has been placed upon the excellent discussion of location quotients and their uses presented by J. M. Mattila and W. R. Thompson, "The Measurement of the Economic Base of the Metropolitan Areas," *Land Economics* 31 (Aug., 1955), 215–28. For further discussions of the location quotient, its uses, and its weaknesses the reader should consult P. S. Florence, "Economic Efficiency in the Metropolis," in R. M. Fisher (ed.), *The Metropolis in Modern Life* (New York: Doubleday, 1955), pp. 85–125; R. B. Andrews, "Mechanics of the Urban Economic Base: General Problems of Base Identification," *Land Economics*, 30 (May, 1954), 164–72; P. Neff and R. M. Williams, "Identification and Measurement of an Industrial Area's Export Employment in Manufacturing," *Proceedings of the Western Committee on Regional Economic Analysis;* and the brief survey of the literature and measurement problems associated with this technique given in Walter Isard, *Methods of Regional Analysis* (New York: Wiley & Sons, 1960), pp. 123–6. Applications of location quotients and related statistics similar to those employed here may be found in R. B. Vance and S. Smith, "Metropolitan Dominance and Integration," in Vance and Demarath (eds) *The Urban South* (Chapel Hill: The University of North Carolina Press, 1954), pp. 114–34 and in Robert L. Carroll, "The Metropolitan Influence of the 168 Standard Metropolitan Area Central Cities,"*Social Forces*, 42 (Dec. 1963), 166–73.

[17] In addition to reflecting the variations in localized "self-sufficiency" being examined here, deviations of I from 1.00 may also occur due to variations in consumption patterns among the SMA's, variations in the productivity of workers in the particular industries among the SMA's, or variations in the levels of technological progress and employment ratios in the several SMA's. The existence of these additional sources of variability are fully recognized and derive directly from the inadequacy of the assumptions underlying the use of the location quotients. These assumptions are described in some detail in Mattila and Thompson, *op. cit.*, p. 217ff. Despite the well-recognized deficiencies of measures of this type for detailed analyses of limited numbers of communities, their utility in "aggregative-inferential" analyses of the type being attempted here appears to be well founded and widely accepted. Nevertheless, the existence of this source of error in the data and its interpretation must be recognized and taken into consideration in any interpretation of the findings reported here.

The effect of using data based on place of residence rather than upon place of employment also has an effect upon the results examined here. The distortions introduced in the delimitations and evaluations made here do not appear to be at all serious, however. The major effect of using data of this nature is to introduce into this analysis the consideration of not only interactions based upon the procurement and exchange of local goods and services but also those interactions and exchanges which are generally subsumed under the heading of "journey to work."

TABLE 1. ILLUSTRATIVE VALUES OF THE LOCATION QUOTIENT FOR LOCAL SERVICE INDUSTRIES IN THREE SELECTED LOCALITIES

Locality and Industry[a]	Type of Unit		
	Smaller than SMA[b]	Equal to SMA	Larger than SMA[c]
Grand Rapids, Mich.			
Construction	.88	.93	.85
Trucking	1.45	1.39	1.10
Utilities	.95	.91	.81
Retail Food	1.19	1.12	1.00
Retail Other	1.12	1.05	.89
Repair services	1.01	1.10	1.05
Personal services	1.07	.96	.83
Medicine	1.17	1.02	.82
Education	.87	.84	.84
Other Professional	1.10	.96	.72
Salt Lake City, Utah			
Construction	1.38	1.38	1.28
Trucking	1.37	1.26	.99
Utilities	1.17	1.13	1.05
Retail Food	1.00	.94	.85
Retail Other	1.33	1.22	1.05
Repair services	1.13	1.08	.96
Personal services	1.02	.93	.79
Medicine	1.19	1.04	.88
Education	1.32	1.22	1.28
Other Professional	1.39	1.24	.94
Youngstown, Ohio			
Construction	.75	.75	.75
Trucking	.86	.83	.80
Utilities	.85	.78	.82
Retail Food	1.19	1.03	.98
Retail Other	1.04	.90	.87
Repair services	.73	.85	.88
Personal services	.98	.81	.81
Medicine	.97	.80	.81
Education	.79	.79	.81
Other Professional	.99	.82	.83

[a] The abbreviated names for the industries refer to the ten industrial categories cited in the text as the local service industries. The correspondence between these abbreviated titles and the complete titles should be obvious.

[b] The unit smaller than the SMA is made up of the urbanized area where available and the central city where not available. In each of the three localities examined here the urbanized area was used.

[c] The unit larger than the SMA is made up of the original SMA plus the first ring of contiguous counties surrounding it.

If one grants the general validity of the arguments concerning the meaning and measurement of trading areas which have been outlined above, it is then possible to argue on the basis of these findings that the SMA of Grand Rapids is more truebounded than are the SMA's of either Youngstown or Salt Lake City. Put in other words, we could say that the SMA of Grand Rapids is a more meaningful unit than the other two SMA's with respect to their ability to delimit a relatively closed and self-sufficient trading area in localized goods and services.

Still further implications are derivable from these findings, however. It should also be noted that a unit larger than the SMA seems to offer a fairly close approximation to the trading area (values of the location quotient closest to 1.00) for six of the ten local service industries in Salt Lake City, for two of the ten local service industries in Grand Rapids and for three industries in Youngstown. Conversely, units smaller than the SMA seem to offer the best approximations to the trading area of seven out of ten local service industries in Youngstown, two out of ten industries in Salt Lake City, and three out of ten industries in Grand Rapids. Based on these observations, there appears to be some validity in arguing that at least among these three localities, *the SMA of Grand Rapids is relatively truebounded, the SMA of Salt Lake City is relatively underbounded and the SMA of Youngstown is relatively overbounded.*

A detailed examination of all of the SMA's in the United States on a basis similar to this would then appear to be possible in order to gain further insight into the degree of overboundedness, trueboundedness, or underboundedness of each. Before attempting to extend our analysis to other SMA's, however, a number of additional points must be taken into consideration.

Three basic problems arise in considering values of the location quotient such as those given in Table 1. The first is that among these ten industry groups some are likely to be much more important than others in terms of the degree to which they contribute to local integration and interdependence. Thus retail trade services in either of the two categories considered here may be generally expected to provide a much more important component to local integration and interdependence than would either medical services or construction services. Certainly a far greater proportion of the interaction which takes place in a metropolitan area revolves around the flow of goods, services and people to and from retail shopping centers than would be involved in exchanges and interactions taking place with respect to the provision of medical services either in journeys to consume or in journeys to work. The relative importance of these several types of activities is at least partially reflected by the number of persons employed in each.

A second problem which arises in the interpretation of these figures rests upon the crudeness of the initial classification. Although all of these industries have been chosen as local service industries, there exists considerable variation among them in the degree to which they are truly local in character. Thus the Retail trade categories and Utilities and sanitary services category tend to be much more highly localized than do categories such as Trucking and warehousing services or Educational services. Some means of controlling for the relative degree of "localness" of these different industries must be introduced in addition to the problem of weighting for their relative importance in contributing to local integration.

A third problem rests on the rather obvious fact that the degree to which any given location quotient deviates from 1.00 is a fairly clear indication of the extent to which the areal unit in question provides a good approximation to the trading area for that industry. Values of the location quotient which are very close to 1.00 should be counted more heavily than those which are quite different from 1.00. It should be noted that for our purposes deviations of the location quotient below 1.00 indicating "underproduction" are equally as important as deviations above 1.00 indicating "overproduction." A deviation from 1.00 in either direction indicates a lack of self-sufficiency and the probable existence of an exchange relationship with other outside populations for the balancing of the departure from self-sufficiency. Our analysis, therefore, considers the absolute deviation of the location quotient from 1.00 without regard for its direction.

It seems clear that some means of taking each of these three factors into consideration must be introduced before we can make meaningful comparisons among any large number of SMA's on the basis of all ten groups of local service industries at once. Such an attempt has been made in this analysis and is represented in the Index of Localized Self-Sufficiency, S, which is described below. This measure attempts to provide an aggregate measure of the extent to which any given areal unit approximates a self-sufficient trading area for all ten of the local service industries at once, taking into consideration their relative importance, their relative degree of localness or ubiquity, and the degree to which each of their location quotients deviates from 1.00.

The Index of Localized Self-Sufficiency, S, may be defined algebraically as:

$$S = 1.000 - \frac{\displaystyle\sum_{i=1}^{10} \frac{w_i \left| 1.00 - I_i \right|}{\sigma_i}}{\displaystyle\sum_{i=1}^{10} \frac{w_i}{\sigma_i}} \tag{2}$$

where S represents the Index of Localized Self-Sufficiency; w_i represents the proportion of the total number employed in all the local service industries which are employed in industry i for the entire non-southern U. S. population; I_i represents the location quotient for industry i in a particular locality; and σ_i represents the standard deviation of the location quotient over all the non-southern SMA's. The denominator in the above equation represents a constant term which is introduced in order to reduce the right hand term to simple multiples of 1.000. The value of this constant term is, of course, dependent upon the values of w_i and σ_i, but these values are the same for all the SMA's considered at any particular point in time. The entire right-hand term of the formula is subtracted from 1.000 in order to produce a statistic which will increase in value as the degree of self-sufficiency increases. This index is thus based upon the weighted sum of the absolute standard deviations of I from 1.00.[18]

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[18] It is worth pointing out once more that the manner in which the Index of Localized Self-Sufficiency behaves for different SMA's is fundamentally determined by the particular forms of economic activity which are included

It may now be seen that the value of S will tend to be greater as the industries considered exhibit little deviation from 1.00. Furthermore, the effect of the deviation of a particular industry from 1.00 on the value of S will depend upon its relative importance as indicated by the number of persons employed in the industry nationally and upon its relative ubiquity as indicated by the standard deviation of the location quotient as well as upon its absolute degree of deviation from 1.00. Since the value of the location quotient can never be less than 0.00 the upper limit of S is fixed at 1.000. The lower limit of S, depending as it does upon the upper limit of the location quotients, appears to be theoretically indeterminate. Negative values of S are certainly possible, although no values of S less than 0.0 have been observed for any of the units considered here or in the earlier research upon which this report is based.

Having arrived at this aggregative measure of the degree to which a given areal unit approximates a self-sufficient trading area for all local service industries taken together, we may now return to our examination of the rest of the 1950 SMA's in the United States. Table 2 presents the values of the Index of Localized Self-Sufficiency for each of the 103 SMA's considered here in conjunction with the values obtained for the two areal units larger and smaller than the SMA.

The SMA's have been listed alphabetically according to their apparent type of boundary discrepancy. In a few instances the results do not appear to be sufficiently distinctive to allow a clear-cut evaluation and these SMA's are classed as Indeterminate.

A comparison of the values of S obtained for Grand Rapids, Salt Lake City, and Youngstown with the values of the location quotient reported above indicate substantial agreement with our earlier evaluation of the quality of the SMA in each of these three instances. The highest value of S (.925) for Grand Rapids is attained for the SMA, indicating that the SMA appears to be relatively true-bounded in comparison with its urbanized area and the unit larger than the SMA. For Salt Lake City, the SMA plus contiguous counties exhibits the largest value of S (.878) apparently justifying our earlier assertion that the SMA of Salt Lake City is underbounded. Finally, the high value of S for the urbanized area of Youngstown (.894) would also seem to bear out our earlier argument that the SMA of Youngstown appears to be overbounded.

A totally unambiguous evaluation of every SMA according to its values of the Localized Index of Self-Sufficiency does not appear to be possible at this time. No clear cut statistical criterion for determining a significant difference between two differing values of S has been found.[19] In the majority of the cases

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in its composition. If fewer localized services had been included and more of an emphasis on non-localized activities had been obtained, the Index would, of course, be more sensitive to underboundedness among the SMA's analyzed. Conversely, the Index would be less sensitive to underboundedness and more sensitive to overboundedness if the activities chosen had been restricted to a set representing a more localized orientation than those ultimately used.

Although the set of activities ultimately used in this analysis seems reasonable to the writer, the desirability of utilizing alternative sets of activities and comparing their results to those reported here is evident. It is hoped that this analysis may stimulate others to undertake further investigations of SMA and SMSA boundaries utilizing variations of the techniques described here or developing completely new and independent criteria of evaluation.

[19] A careful search of the literature on sampling error and measurement error in census data of the type employed here yielded information which led us to conclude that the effect of such errors on the standard error of this statistic, S, would be quite small. According to the best estimates we have been able to establish it seems very likely that the standard error of this statistic is considerably smaller than .02, possibly by a factor as great as 100 or 1000.

TABLE 2. VALUES OF THE INDEX OF LOCALIZED SELF-SUFFICIENCY, S, FOR UNITS SMALLER THAN, EQUAL TO AND GREATER THAN THE SMA FOR EACH OF 103 NON-SOUTHERN SMA'S; TENTATIVELY CLASSIFIED ACCORDING TO THEIR LOGICAL POSSIBILITIES OF DISCREPANCY

Name of SMA Boundary Classification	Smaller than SMA[a]	Equal to SMA	Larger than SMA[b]
OVERBOUNDED:			
Allentown-Beth-Easton, Pa.	.918	.891	.847
Altoona, Pa.	.844	.794	.778
Bridgeport-Stamford-Norwalk, Conn.	.892	.849	.842
Brockton, Mass.	.910	.881	.861
Fall River-New Bedford, Mass.	.890	.883	.887
Flint, Mich.	.871	.849	.828
Hamilton-Middleton, Ohio	.933	.842	.844
Harrisburg, Pa.	.906	.903	.851
Johnstown, Pa.	.839	.719	.731
Ogden, Utah	.863*	.850	.775
Pittsburgh, Pa.	.912	.879	.856
Saginaw, Mich.	.906	.876	.835
San Bernardino, Calif.	.891	.863	.856
Scranton, Pa.	.803[c]	.803	.805
Trenton, N.J.	.895	.877	—
Wilkes-Barre-Hazelton, Pa.	.802[c]	.789	.793
Worcester, Mass.	.880	.851	.853
Youngstown, Pa.	.894	.863	.856
UNDERBOUNDED:			
Albuquerque, N.M.	.639*	.747	.787
Atlantic City, N.J.	.490	.587	.624
Binghamton, N.Y.	.842	.894	.927
Boston-Lowell-Lawrence, Mass.	.861	.895	.905
Cedar Rapids, Iowa	.696	.835	.874
Chicago, Ill.	.837	.862	.878
Cincinnati, Ohio	.809	.839	.890
Cleveland, Ohio	.894	.907	.937
Columbus, Ohio	.819	.856	.934
Davenport, Rock Island-Moline, Ill.	.828	.888	.930
Decatur, Ill.	.793	.879	.943
Denver, Colo.	.718	.755	.804
Des Moines, Iowa	.663	.725	.862
Evansville, Ind.	.812	.873	.934
Fort Wayne, Ind.	.801	.861	.924

[a] In most instances the unit smaller than the SMA which was employed was the urbanized area. Localities where the central city was used due to the lack of an urbanized area are indicated by an asterisk.

[b] In every case the unit larger than the SMA consists of the SMA county or counties plus the first ring of contiguous non-SMA counties surrounding it. A blank indicates that there were no non-SMA counties surrounding the SMA county in question.

[c] The values of S for the central cities of Scranton and Wilkes-Barre-Hazleton are .827 and .859, respectively.

TABLE 2. (*Continued*)

Name of SMA Boundary Classification	Smaller than SMA[a]	Equal to SMA	Larger than SMA[b]
Indianapolis, Ind.	.777	.798	.863
Kansas City, Mo.	.701	.737	.813
Lansing, Mich.	.793	.844	.887
Lima, Ohio	.759*	.903	.915
Lincoln, Neb.	.558	.690	.840
Madison, Wis.	.529	.742	.899
Milwaukee, Wis.	.862	.879	.903
Minneapolis-St. Paul, Minn.	.767	.802	.848
Omaha, Neb.	.789	.836	.878
Peoria, Ill.	.840	.928	.952
Phoenix, Ariz.	.725	.850	.879
Portland, Ore.	.694	.810	.870
Pueblo, Colo.	.830	.831	.931
Racine, Wis.	.880	.885	.929
Rochester, N.Y.	.857	.896	.924
Sacramento, Calif.	.794	.847	.872
St. Joseph, Mo.	.762	.838	.937
St. Louis, Mo.	.854	.905	.942
Salt Lake City, Utah	.765	.818	.878
San Francisco-Oakland, Calif.	.805	.845	.869
San Jose, Calif.	.809	.872	.902
Seattle, Wash.	.788	.837	.896
Sioux City, Iowa	.663	.752	.872
Sioux Falls, S.D.	.586*	.731	.858
South Bend, Ind.	.842	.860	.891
Spokane, Wash.	.707	.808	.866
Springfield, Ill.	.717	.847	.923
Springfield, Mo.	.634	.786	.923
Syracuse, N. Y.	.807	.883	.952
Terre Haute, Ind.	.688	.804	.926
Toledo, Ohio	.874	.899	.941
Topeka, Kan.	.673	.731	.875
Wichita, Kan.	.696	.752	.835
TRUEBOUNDED:			
Albany-Schen-Troy, N. Y.	.895	.947	.941
Bay City, Mich.	.840*	.908	.884
Buffalo, N. Y.	.884	.928	.928
Canton, Ohio	.858	.906	.889
Dayton, Ohio	.900	.926	.904
Duluth-Superior, Minn.	.839	.906	.845
Fresno, Calif.	.641	.880	.869
Grand Rapids, Mich.	.874	.925	.883
Green Bay, Wis.	.724*	.869	.852

TABLE 2. (*Continued*)

Name of SMA Boundary Classification	Smaller than SMA[a]	Equal to SMA	Larger than SMA[b]
Hartford-New Britain-Bristol, Conn.	.877	.936	—
Jackson, Mich.	.704*	.855	.841
Kalamazoo, Mich.	.868	.888	.880
Lancaster, Pa.	.779	.843	—
Los Angeles, Calif.	.792	.806	.802
Manchester, N. H.	.901	.927	.917
Muncie, Ind.	.800*	.920	.891
New Haven-Waterbury, Conn.	.919	.939	.939
Pittsfield, Mass.	.878*	.902	—
Portland, Me.	.773	.887	.867
Providence, R. I.	.938	.950	.939
Reading, Pa.	.849	.909	—
San Diego, Calif.	.891	.919	.915
Springfield, Ohio	.849	.921	.913
Stockton, Calif.	.802	.919	.917
Utica-Rome, N. Y.	.841	.876	.866
Waterloo, Iowa	.824	.883	.882
York, Pa.	.728	.866	—
INDETERMINATE:			
Akron, Ohio	.868	.916	.917
Detroit, Mich.	.920	.927	.928
Erie, Pa.	.870	.886	.891
Kenosha, Wis.	.868*	.869	—
Lorain-Elyria, Ohio	.861*	.828	.869
New York-N.E. New Jersey	.831	.845	.851
Philadelphia, Pa.	.869	.915	.920
Rockford, Ill.	.905	.931	.936
Springfield-Holyoke, Mass.	.894	.905	—
Tacoma, Wash.	.853	.872	.874

given in Table 2 some tentative evaluation seems quite reasonable, however, simply upon the basis of interpreting our findings in terms of their conceptual meaning relative to the problem at hand. Eighteen of the 103 SMA's have been accordingly classed as overbounded, 48 SMA's have been classed as

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For a more complete discussion of the question of statistical inference with respect to this statistic see Allan G. Feldt, *op. cit.*, pp. 98–102. The major sources of information on this topic were derived from Eckler and Hurwitz, "Response Variance and Biases in Censuses and Surveys," *Bulletin of the International Statistical Institute*, 1958, 36: pp. 12–35; Hansen, Hurwitz and Bershad, "Measurement Errors in Censuses and Surveys," a paper presented at the annual meeting of the International Statistics Institute in Tokyo, 1960, U. S. Bureau of the Census (processed); Hansen and Pritzker, "The Post Enumeration Survey of the 1950 Census of Population: Some Results, Evaluation, and Implications," a paper presented at the Annual Meeting of the Population Association of America, Ann Arbor, 1956, U. S. Bureau of the Census (processed); U. S. Bureau of the Census, *The Accuracy of Census Statistics With and Without Sampling* (Washington, D. C.: Bureau of the Census, Technical Paper No. 2, 1960); and U. S. Bureau of the Census, *The Post Enumeration Survey: 1950* (Washington, D. C.: Bureau of the Census, Technical Paper No. 4, 1960).

underbounded, and 27 SMA's classed as truebounded. Ten SMA's were classed as indeterminate rather than attempting to force them into one of the three possible categories of boundary discrepancy.

The basis for the judgments given in Table 2 should be quite clear in most instances upon examining the values of S given for each of the SMA's.[20] It is to be expected, however, that other interpretations of some of the SMA's will be given by various readers of this report even though they may agree with the theoretical and statistical manipulations which have led to these results. The absence of any set of totally unambiguous criteria for the interpretation of these findings is certainly deplorable. Nevertheless, the results presented here and the interpretations made of them offer some basis for a general evaluation of SMA's which has been totally lacking heretofore, at least to the knowledge of this writer. It should be reiterated, however, that these results are of primary utility in attempting to evaluate large numbers of SMA's and their validity may be quite low when applied to any particular case. Detailed information on traffic patterns, trading areas, and capital flows of any particular SMA should be given precedence over any of the results reported here. Major errors may be inherent in the results obtained for some individual SMA's reported on here.[21]

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[20] In arriving at the classifications and judgments presented in Table 2 two kinds of factors were considered The first was the relative magnitude of the value of S obtained for different types of configurations and the second was the relative areal size of the configurations being considered. A change in the value of S was taken to be important and significant if it amounted to a difference between the two units of .010 or more. It should be pointed out that importance and significance in this context refer more to questions of theoretical significance and importance than to statistical significance and that such criteria are quite subjective. The relative areal sizes of the configurations being observed was taken into account by giving precedence to smaller configurations whenever values of S were obtained in two successive configurations which did not exhibit any substantial increase for the larger unit over the smaller unit. Thus, when the unit smaller than the SMA had nearly the same value of S as the SMA itself the SMA was classed as overbounded. Similarly, when the configuration larger than the SMA exhibited a value of S not greatly different than the value for the SMA itself, the SMA was classed as truebounded. The reasons for taking the areal size of the units into account in the classifications are fairly straightforward and are rooted in the theoretical and operational derivation of the statistic, S. An SMA which is coextensive with the boundaries of the United States must have a value of S equal to 1.000 by definition. But such a unit is obviously very different from the conceptualization of a metropolitan area and probably contains many metropolitan areas within itself, any or all of which could also have values of S equal to 1.000. Therefore, in considering the effects of an increase of size on the value of S for an SMA one should try to insure not allowing the unit to become so large as to possibly embrace more than one self-sufficient metropolitan area. By the same token, an SMA which does not exhibit a value of S which is greater than the value obtained for its central city or urbanized area is not likely to contain any substantial proportion of the trade or commuting areas centered on the central city of the SMA other than those already encompassed by the limits of the central city or urbanized area itself. Therefore, the SMA seems likely to be too extensive and to add basically unrelated populations to the central populations of the metropolitan area. The most suitable classification for such an SMA would be overbounded. Thus, throughout the classifications of SMA's which have been attempted here, precedence has been given to those units which are as small in areal extent as possible but which still exhibit values of S which are as large as possible.

Despite the subjective nature of the considerations taken into account in classifying and judging the SMA's in Table 2, a substantial amount of agreement with these judgments seems possible among most observers. Some disagreement must be expected given the absence of any purely objective and replicable criteria for classification but the amount of such disagreement among different observers is much less than it would be if the single criterion of evaluation, S, were not available to them.

[21] The case of Madison, Wisconsin is possibly the one SMA which is most subject to distortion with the methods of analysis employed here. The central city of this SMA is both a university center and the state capital. As such it employs a number of persons in educational, medical, and other professional services which are definitely nonlocal in character. Nevertheless, the data available to us have forced us to treat these activities in conjunction with their more local counterparts. In such an instance the interpretation of Madison as being underbounded may be quite misleading and contrary to fact. We have persisted in classifying Madison as such, however, in order to maintain consistency with the interpretations made of other SMA's in the country about which we have less specific knowledge. The existence of such possibilities for discrepancy in our findings do not seem likely to vitiate the general validity of the approach employed here.

3. THE VALIDITY OF THE 1950 SMA BOUNDARIES

Making some allowances for the problems of distortion in the data and the difficulties of making any strictly objective interpretation of the statistics employed, it still is quite evident that a substantial number (47%) of the SMA's examined here appear to be underbounded. Such a finding would appear to lend some weight to the arguments for expanding the areal scope of the SMA's still farther and certainly offers considerable justification for the establishment of SMA's in contradistinction to the earlier Metropolitan Districts which were considerably smaller in areal extent.[22]

It might also be argued, however, that this finding in itself simply indicates that the conceptual interpretation of the SMA made in this analysis embraces a more extensive and inclusive area than had been originally envisioned by its creators. Such an argument cannot hold, however, in light of the fact that an almost equally large number of SMA's were found to be either true-bounded or overbounded. Twenty-six per cent of the SMA's are classed as truebounded and another 17 per cent as overbounded. Although it would appear that in many instances the SMA should be expanded outwards, there are a number of instances where the SMA should be decreased, at least according to the criteria which we have used here.

Some consideration should be given to the factors which tend to be associated with the different types of boundary discrepancy which have been examined here. An extensive analysis of such factors has not been undertaken, but a few preliminary findings are of interest and will be discussed below. Further investigation into the nature of such factors and their affect upon boundary discrepancies should provide additional insight into the nature of the metropolitan community and lead to even better SMA delimitations in future years.

In his discussion of the expansion of communities and interregional organization, Hawley mentions two factors which tend to limit the areal expansion of an urban community into its hinterland.

> The territorial extent to which an organization may expand is restricted by one of two factors. In any given state of transportation facilities expansion is limited by the time and cost involved in reaching the center or market. There tends to be a point on any given route beyond which the cost of transfer to the market equals or exceeds the difference between the cost of production and the market price. That point marks the maximum scope of the area of interdependence . . .
>
> Expansion from a particular center is also checked by the development of rival centers of expansion which tend to appear in all the outlying regions. . . . Local services develop, many of them administratively independent and hence in competition with those provided by the older center. With the appearance of manufacturing es-

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[22] It is interesting to compare our findings here with the enlargement of the areal scope of some SMA's which took place between 1950 and 1960 when they were delimited as Standard Metropolitan Statistical Areas. If we exclude from consideration the 12 New England SMA's delimited on township lines and the two which were reconstituted as Standard Consolidated Areas (Chicago and New York City), we find that eight out of forty-seven (17%) underbounded SMA's were expanded in 1960; two out of twenty (10%) truebounded SMA's were expanded; and none of the Indeterminate SMA's were expanded. Among the overbounded SMA's, only one out of fourteen (7%) was expanded between 1950 and 1960 and one, Youngstown, Ohio, was actually *decreased* in areal scope. Of the 89 SMA's considered in this comparison, Youngstown is the only one which was decreased in extent between the two censuses.

> tablishments the outlying region becomes a market for its own raw materials as well as those of other regions. Thus the region, through the agency of its principal city, becomes self-sufficient in respect to an increasing number of requisite services. Conversely, its dependence on the center of origin narrows to one or a few special requirements such as financial services, or perhaps only for an exchange of manufactured products.
>
> The two centers, in fact, become active competitors, especially as the activities carried on in one are duplicated in the other . . . To the degree to which the new center succeeds in extending its dominion that of the older center is hemmed in and checked. There may even be contraction of the area tributary to the older center, for competition arises over the traffic with intervening settlements.[23]

Although variations, in the speed and cost of transportation facilities are certainly important, they do not appear likely to be of great utility in our examination. It seems safe to assume for our purposes that the level of transport technology is approximately equal for all American cities. Some differences certainly do occur but they do not appear likely to be of sufficient magnitude to necessitate an examination at this time. The rather high incidence of underbounded SMA's in the midwestern and western states where the daily commuting distance is generally greater than in other parts of the country may be taken as partial indication of the importance of transportation factors on the extent of an SMA.

Our attention will be directed to the second factor mentioned by Hawley, the existence of competing urban centers in close proximity to the center under consideration. The degree to which the extensiveness of a metropolitan area is curtailed should be directly related to the degree to which the extensiveness of that metropolitan area is curtailed by competing centers.

We would thus expect to find more overbounded SMA's among those located near other SMA's than we would find among those SMA's located at some distance from other SMA's. Conversely, we should also expect to find more underbounded SMA's among those SMA's which are located at some distance from competing centers than among those which are located in some higher degree of proximity to competing centers. One of three distance categories has been assigned to each SMA based upon the airline distance to the nearest central city of another SMA: less than fifty miles, between fifty and one hundred miles, and more than one hundred miles.[24] The percentage distributions of overbounded, truebounded, and underbounded SMA's in each of these distance categories are given in Table 3.

The anticipated relationship between type of boundary discrepancy and proximity to other urban centers is well supported by the findings presented in Table 3. The value of Kendall's τ_c for the relationship between type of

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[23] Hawley, *Human Ecology, op. cit.*, pp. 361–2.

[24] Where appropriate these distance categories have been taken directly from those given by Hawley, *The Changing Shape of Metropolitan America* (Glencoe, Ill.: The Free Press, 1956), Chapt. V and Appendix Table 1. Hawley's assignments are based upon measures of distance obtained from C. A. Whitten, *Air-Lines Distances Between Cities in the United States*, U. S. Dept. of Commerce, Coast and Geodetic Survey, Special Publication No. 238. (U. S. Gov't Printing Office: Washington, D. C., 1947). In the few cases where different SMA's are being considered here than in Hawley's work, as in New England, straight line mileage distances between the appropriate cities were substituted for air-line distances.

TABLE 3. NUMBER AND PERCENTAGE DISTRIBUTION OF SMA's WITH THE THREE TYPES OF BOUNDARY DISCREPANCY BY DISTANCE TO NEAREST CENTRAL CITY OF ANOTHER SMA

Type of Boundary Discrepancy	Distance to Nearest Central City[a]							
	Less than 50 Miles		50 to 100 Miles		More than 100 Miles		Total	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Overbounded	16	31.4%	2	7.1%	0	0.0%	18	19.4%
Truebounded	17	33.3	7	25.0	3	21.4	27	29.0
Underbounded	18	35.3	19	67.9	11	78.6	48	51.6
Total	51	100.0%	28	100.0%	14	100.0%	93[b]	100.0%

[a] Distance categories derived from A. H. Hawley, *Changing Shape of Metropolitan America* (Glencoe, Ill., The Free Press, 1956), chapt V and Appendix Table 1. See also footnote 24 above.

[b] Ten SMA'S whose boundary discrepancy has been classed as Indeterminate are omitted.

boundary discrepancy and distance to nearest central city is +.33, demonstrating a moderately strong relationship.[25]

Other factors which would appear likely to be related to the type of boundary discrepancy of an SMA might be sought in the age of the central city and the rate of growth of the metropolitan area. Following Hawley's argument cited above, one would expect to find more instances of overbounding in the older and more slowly growing metropolitan areas since these would be the areas which would have had the best opportunity to develop alternative trading areas centered in other cities located in the hinterland of the metropolis. Some slight degree of relationship between the boundary characteristics of SMA's and the age and growth rate of the SMA's has been noted elsewhere but these findings are not sufficiently definitive to warrant their inclusion here.[26]

Finally, it would seem worthwhile to consider briefly the relationship between the types of boundary discrepancy occurring in SMA's, their levels of localized self-sufficiency, and their population sizes. Such an examination would appear to be justified simply on the basis of the considerable importance which has been attached to the size of cities and metropolitan areas in most investigations of their "metropolitanness" and of their extensiveness. Underlying much of the research on metropolitan areas has been the usually unstated assumption that the larger the city or metropolitan area being considered the greater its influence over the surrounding hinterland and the more extensive its ties of interdependence to peripheral populations. Population size itself is the major criterion utilized in the determination of whether a particular city should be classed as an SMA.

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[25] Kendall's τ_c is a measure of the strength of a relationship between two ordinal scale variables with a large number of ties such as would occur in a frequency table. It may be interpreted in a manner roughly analogous to a correlation coefficient. For details of its computation and interpretation see H. M. Blalock, *Social Statistics* (New York: McGraw-Hill Book Company, 1960), pp. 321–4 or most other basic statistics texts.

[26] For a preliminary discussion of these findings see Allan G. Feldt, *op. cit.*, pp. 120–31.

TABLE 4. PERCENTAGE DISTRIBUTION OF TYPES OF BOUNDARY DISCREPANCIES BY SIZE OF SMA

Type of Boundary Discrepancy	Size of SMA							
	50–199 thousand		200–499 thousand		500 or more thousand		Total	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Overbounded	5	13.9%	9	28.1%	4	16.0%	18	19.4%
Truebounded	11	30.6	9	28.1	7	28.0	27	29.0
Underbounded	20	55.6	14	43.8	14	56.0	48	51.6
Total	36	100.1%	32	100.0%	25	100.0%	93[a]	100.0%

[a] Ten SMA's whose boundary discrepancy has been classed as Indeterminate are omitted.

Despite the general importance given to population size in most urban research, however, nothing in the discussion of the metropolitan area which has taken place in this paper has made any mention of the size of the central city or the SMA. Nothing in our discussion of trading areas and the logical possibilities of boundary discrepancy has depended upon the population size of the areas being considered. The only instance in which the size of a city or a metropolitan area has had any bearing upon the investigation undertaken here has been in the dependence upon the size of the central city which resulted in its original selection as an SMA by the Bureau of the Census. Nothing in our theoretical formulation would then lead us to expect any relationship between the population size of a city or of an area and its degree of localized self-sufficiency or its type of boundary discrepancy. Surprisingly enough, an inspection of the actual relationship between the value of the Index of Localized Self-Sufficiency of the SMA's and their population size supports these conclusions, the product moment correlation being .051. An examination of the type of boundary discrepancies which occur in SMA's of different population size classes also demonstrates little relationship between these two factors.

The results given in Table 4 fail to demonstrate any clear relationship between boundary discrepancy and the size of the SMA other than the possibility of a slight tendency for SMA's of intermediate size (200,000–499,000) to be more frequently overbounded than other size SMA's.[27]

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[27] It could be argued that another form of relationship between the population size of an SMA and the behavior of S may exist which is not treated in the discussion given here. The nature of this relationship would be such that values of S for alternative configurations would be less susceptible to change in large SMA's than in small SMA's. Thus an SMA of 1,000,000 persons with an adjacent population of 100,000 would be less likely to exhibit large changes in S when the adjacent population is included than would be true for an SMA of 100,000 persons with an adjacent population of 100,000. This argument appears sound and it is admitted that some relationship between population size and the sensitivity of the index, S, may exist. No evidence of this pattern has been found in this analysis, however. The 10 SMA's classified as indeterminate might be considered as units which exhibited relatively low susceptibility to change but the SMA's so classified are evenly distributed among the three population size classes distinguished in Table 4.

Although the argument concerning the effects of population size may be valid, two important aspects of this problem must be borne in mind. First, the question of the sensitivity of the index to size must always be considered as a question of the relative sizes between the population of the SMA itself and the population of the immediately adjacent territory rather than simply a question of the absolute size of the SMA alone. Secondly, it must be remembered that the effect of adding a population increment to the SMA population is not determined so much by the

The lack of relationship between the size of an SMA and its boundary characteristics does not appear to be too surprising in light of the theoretical reasoning underlying this present investigation. It does appear to be somewhat disconcerting, however, in view of the considerable emphasis which has been given to population size in many other investigations of metropolitan phenomena. Certainly this aspect of metropolitan area delimitation warrants further investigation.

4. CONCLUSIONS

The results reported here clearly demonstrate that there exists considerable variability in the suitability of the Standard Metropolitan Area as a valid approximation to a meaningful metropolitan area, at least in terms of the conceptualization of the metropolitan area which has been advanced in this paper. The fact that more SMA's tend to be underbounded than overbounded or truebounded lends support to the argument that the SMA's constitute a considerable improvement over the earlier Metropolitan Districts and helps to justify the expansion of the boundaries of a number of SMA's which has taken place in the 1960 census. Finally, the marked relationship between overboundedness and proximity to other SMA's offers both a validation of the evaluation procedures developed here and an important insight into the character of the metropolitan area.

Further analyses of the meaning and operationalization of the metropolitan area are necessary in order to provide a sound basis for future improvement and clarification of the statistical artifacts with which we view the world. Such analyses should spring from a wide variety of theoretical and conceptual backgrounds and could provide complimentary or even contradictory evaluations of the metropolitan area concept to those presented here. A more complete examination of the relationship between boundary discrepancies and other characteristics of metropolitan areas would appear to be called for. Further analyses of the type presented here at other census periods would undoubtedly shed additional light on the meaning and development of the metropolitan area.

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size of the increment but rather by its economic composition. Thus a very small population added to a very large SMA may produce a considerable change in the value of S if the incremental population is made up of persons engaged in local services which directly compliment employment deficiencies in such activities for the SMA which have been established by the values of the location quotients for the SMA.